Kafai, Y. & Peppler, K. (2011). Youth, Technology, and DIY: Developing Participatory Competencies in Creative Media Production. In V. L. Gadsden, S. Wortham, and R. Lukose (Eds.), *Youth Cultures, Language and Literacy*. *Review of Research in Education*, Volume 34.

Youth, Technology, and DIY: Developing Participatory Competencies in Creative Media Production

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Abstract. Traditionally, educational researchers and practitioners have focused on the development of youths' critical understanding of media as a key aspect of new media literacies. The 21st Century media landscape suggests an extension of this traditional notion of literacy – an extension that sees creative designs, ethical considerations, and technical skills as part of youth's expressive and intellectual engagement with media as participatory competencies. These engagements with media are also part of a growing Do-It-Yourself, or DIY, movement involving arts, crafts, and new technologies. The purpose of this chapter is to provide a framework and a language for understanding the multiple DIY practices in which youth engage while producing media. In the review, we will first provide a historical overview of the shifting perspectives of two related fields—new media literacies and computer literacy —before outlining the general trends in DIY media cultures that see youth moving towards becoming content creators. We then introduce how a single framework allows us to consider different participatory competencies in DIY under one umbrella. Special attention will be given to the digital practices of remixing, reworking, and repurposing popular media among disadvantaged youth. We will conclude with considerations of equity, access, and participation in after-school settings and possible implications for K-12 education.

Traditionally, educational researchers and practitioners have focused on the development of youths' critical understanding of new media as one key aspect of digital literacy (Buckingham, 2003; Gilster, 2007). Today, youth not only consume media when browsing the Internet and sharing information on social networking sites, but they also produce content when contributing to blogs, designing animations, graphics and video productions (Ito et al., 2009). This new media landscape suggests an extension of what critical participation means in new media literacy, extending the metaphor of "reading the world to read the word" (Freire & Macedo, 1987) to include writing new media texts in a digital era. In an effort to map out the participatory competencies needed in this new media landscape, Jenkins and colleagues (2009) include creative designs, ethical considerations, and technical skills to capture youth's expressive and intellectual engagement with new media. More recently, these efforts to produce your own media have also been associated with the growing Do-It-Yourself, or DIY, movement (Guzetti & Yang, 2010; Knobel & Lankshear, 2010) involving arts, crafts, and new technologies (Eisenberg & Buechley, 2008; Spencer, 2007). Educators should be especially interested in DIY communities given the amount of time youth voluntarily spend in intense learning as they tackle highly technical practices, including film editing, robotics, and writing novels among a host of other activities across various DIY networks.

One aspect of creative media production that has received little attention, if any, in these broad examinations of youths' DIY engagements with digital media concerns the use of programming as a production tool and the focus of a learning community (Peppler & Kafai, 2007). When youth program games, animations, interactive art or digital stories, they not only create program code or texts in the traditional sense but also engage in creating, repurposing and remixing multi-modal representations (Jewitt, 2009). While such activities may seem more pertinent to the more exclusive domain of so-called "computer geeks", they also engage designers in many of the same critical, creative, and ethical considerations that new media literacy researchers consider relevant practices in more common forms of creative media production. It can be no accident that researchers have attached the label of "geeking out" to these types of productions, noting that only a relatively small subset of youth participate in these more complex forms of engagement with media (Ito et al., 2009).

Until now, the discussions about the value of creative media production in education have taken place in two distinct communities — one in the community of new media literacies researchers, the other in the community of computer literacy educators — and these initially appear incommensurate domains. However, research on recent developments in informal learning communities (Kafai, Peppler, & Chapman, 2009), the design of media-rich programming tools (Resnick et al., 2009), and social networks in DIY (Benkler, 2006; Monroy & Resnick, 2009) suggest that researchers studying new media literacies can connect with those studying computer literacy and vice versa. As we will argue, this connection is long overdue because understanding the participatory competencies

of youth draws from both fields. The work highlighted in this review is a first effort to map out the overlapping territory and common issues that educators face as they attempt to bridge these domains in service of offering youth a more robust education. As they do so, opportunities arise to address the participation gap as well as issues of transparency and ethics while youth engage in creative media production (Jenkins et al., 2006). These issues encompass the need to ensure that every young person has access to the skills and experience needed to become a full participant in the 21st century, can articulate their understanding of how media shapes perception, and is knowledgeable of emerging ethical standards that shape their practices as media makers and participants in online communities.

In this review chapter we draw on findings from several recent studies, particularly the work on the new media-rich programming environment, Scratch, to demonstrate that contemporary youth communities move fluidly across these blurry boundaries to engage in both new media literacies and computer literacies in their DIY activities. We will first provide a historical overview of the shifting perspectives of two distinct but related fields – new media literacies and computer literacy – before introducing how a focus on creative media production allows us to consider different participatory competencies in DIY under one umbrella. One goal with this chapter is to unravel some of the historical developments that might have promoted these distinct trajectories of new media literacies studies and computer education in and outside of schools. Special attention will be given to digital practices of remixing, reworking, and repurposing popular media among disadvantaged youth. We will conclude with considerations of equity, access, and participation in after-school settings and possible implications for K-12 education.

Perspectives on Creative Media Production

Before we examine creative media production in more detail, it helps to have a clear understanding where we position our review in the midst of an, at times, confusing array of meanings around literacy and new literacies. Gee's (2010) recent essay was helpful in clarifying the distinctions and developments in the field. He pointed out that new literacies studies are about "studying new types of literacy beyond print literacy, especially digital literacies and literacy practices embedded in popular culture" (p. 31). The focus of our review on new media literacies emphasizes media literacy and how people give and get meaning to and from multi-modal texts and become more reflective about it. In the following section, we will explain how creative media production has come to play a growing role in new media literacies as an approach to engage people reflectively and critically with media.

In addition, we want to include a perspective on creative media production that traditionally has been left outside of the realm of media literacy, namely efforts that focus on computer literacy and more specifically, on programming. While there is no clear academic home for computer literacy, which sometimes is also

referred to as ICT curriculum, IT or technology education (National Research Council, 1999), we refer to it in this review as computer education. Current efforts to define computer literacy or fluency see it as "the ability to reformulate knowledge, to express oneself creatively and appropriately, and to produce and generate information (rather than simply to comprehend it)" (National Research Council, 1999). Others, like diSessa (2001) have connected these abilities to programming in disciplinary fields such as the sciences. Some might argue that programming is too technical and narrow a practice to be associated with new media literacies, and most certainly this sentiment has been prevalent among media researchers who clearly separate these efforts (see Hayes & Games, 2008). In our review, we contend that this exclusion is a more due to old standing academic boundaries between media studies and computer education rather than to a lack of conceptual convergence. Our review will outline how creative media production from either perspective converges as a venue to engage people reflectively and critically with media in the context of DIY productions.

Creative Media Production in New Media Education. Critical analysis of media texts has historically dominated the media education curriculum. From the early 1980's through the mid-90's, theorists rarely explored the role that creative media production played in media literacy, and either held disdain for or purposefully condemned students' creative media production (see for example Masterman, 1980, 1985; Ferguson, 1981; Alvarado et al., 1987), despite trying to promote the scholarly nature of pop culture genres like television. Buckingham states that this was due in part to the pervasive belief that student work lacked scholarly merit but was also attributed to the "…'[t]echnicist' emphasis on production skills that was apparent in some of the new vocationally oriented media courses" emerging in the mid-1980's (2003, p. 124). Work produced in these media courses was seen by many as reproductions of dominant media ideologies, not end products of creative expression. A critical understanding of new media, therefore, became the central focus in this era, rigorously subordinating the "expressive" or "creative" potential of production.

This perspective has been overturned over the past two decades. For the most part, today's educators and researchers (see for example Buckingham *et al.*, 1995; Buckingham, 2003; Peppler & Kafai, 2007) are now arguing that production is a key component in new media education. However, media educators still seem to emphasize critical analyses over production (i.e., reading over writing practices). Initially this could be explained by the lack of portability and dependability of older media (like celluloid film, older cameras, etc), but today's technologies have made more complex forms of production accessible to today's classroom environment.

Given this history, it should come as no surprise that there is only a small amount of academic research on youths' creative media production. Current studies have predominantly focused on youths' experiences producing media on one particular platform (i.e., television, radio, newspaper, etc.), and mostly within the classroom

context (see for example Booth, 1999 or Loveless, 1999). We have referred to this as the "platform model to teaching and learning about production" (Peppler, & Kafai, 2007). While there are many merits to this approach, this perspective overlooks the importance of preparing youth for the new "Convergence Culture" (Jenkins, 2006a/b). The convergence culture is the merger of previously distinct cultural forms and practices. In sum, this is a shift away from the previous platform model where students were taught explicitly about music, film or television, and toward considering how these platforms are increasingly overlapping and enabling new functionality. As media converges, functionalities and tools previously only available to professionals have become accessible to the general public. TV, movies and videos can now be produced cheaply with consumer tools and are distributed via the Internet, circumventing the limited broadcast medium. Perhaps most widely known is a type of fan art where DIY movie producers take advantage of the modifiable sets, characters, and 3D rendering engines made available in commercial videogames to create their own movies, called "machinima", and share these works with thousands of like-minded online fans via the Internet (Lowood, 2006). In this way, the DIY community conducts what is referred to as 'transmedia navigation', crossing from one media type to another (i.e., games to film) (Jenkins, 2006c).

Today, the notion of a "participatory culture" expands our initial understanding of the older sender/receiver model predominantly emphasized in media literacy to include the "skills needed for participation and collaboration — speaking as well as listening, writing as well as reading, producing as well as consuming" (Jenkins, 2006c, p. 2). Although the convergence culture has been widely acknowledged by media educators (see for example Buckingham, 2003), there has been no formal realization of what this might mean for creative media production, more specifically on how we can talk in a coherent fashion about the various dimensions that are involved in creating new media artifacts. While there are many types of new media artifacts that fall into this category – blogs, graphics, games, movies – we have chosen in this chapter to focus on a particular type of new media production – computer programs created in Scratch that allow the creation of various genres. We contend that our findings about media practices extend to other tools and genres as well.

Creative Media Production in Computer Education. In computer education there has always been an emphasis on creative media production in the form of programming code. While Logo programming was prominent in elementary schools in the 1980's, it literally disappeared from the school curriculum by the 1990's. (For a more detailed account of this rather contentious story of Logo in American schools and elsewhere, a chapter in Hoyles & Noss [1996] provides the necessary background; see also Kafai, 2006). It suffices to say that schools turned away from programming as the availability of multi-media packages and the Internet seemingly negated the need for learning programming, a turn that was further supported by the difficulty of finding teachers that were knowledgeable about computers and computer science.

On the tail end of this development a new pedagogical approach to programming appeared, called instructional software design (Harel, 1991), in which students designed full-fledged multimedia software applications rather than just creating program code. This work was inspired by the idea of "design for learning" that had just gained traction in the larger education community (Perkins, 1989). This work drew particularly on Simon's "Sciences of the Artificial" (1981) and Schön's "The Reflective Practitioner" (1983). Taken together, this work emphasized that professional practice in design disciplines are contexts that promote open-ended forms of problem solving and situated learners in the application of academic content in the design of meaningful, authentic applications. Harel's seminal study (1991) illustrated how students as designers of instructional mathematics software became invested in a long-term, meaningful, and integrated project for learning programming and academic content (Palumbo, 1990). Other work in that vein has employed students as designers of a media artifact – be it an instructional science simulation (Kafai & Ching, 2001), historical presentation (Erickson & Lehrer, 1998), mechanical device (Penner, Schauble, & Lehrer, 1998), or engineering design (Hmelo, Colton, & Kolodner, 2000).

One of the first studies that directly combined media education with computer education investigated game design in schools with a class of 16 fourth graders who created computer games that taught younger students in their school about fractions (Kafai, 1995). Over a period of six months, student designers set out to write and execute their own games using Logo programming and designed packaging and advertisements for their games. The designers met about once a month with their intended players – a group of younger students who provided them with feedback on various aspects of their games (see also Kafai, 1998a). Most of the discussion about this work has focused on the observed gender differences in games' narrative, components, aesthetics, and mechanics (Kafai, 1996a; 1998)—most likely because these findings aligned well with then-popular discourse about gender differences in interest and performance in technology and games (e.g., Cassell & Jenkins, 1998). Much less attention was given to the equally important aspects of design practices, such as collaborative planning, and public critiques, that contributed to students' understanding (Kafai, 1996b). These design practices resonate more closely with recent research on toolkits such as Gamestar Mechanic (Salen, 2008) or MissionMaker (Buckingham & Burns, 2008) that engage students in making or modifying games.

Convergence in Approaches to Creative Media Production. What we can learn from the overviews of research on new media literacies and computer literacy is that, at the outset, these two fields seem to have little in common, and indeed, their developments over time took very different trajectories. Our review of creative media production was framed by Sefton-Green's (2006) observation that the dialogue in media education and education research more broadly shifted in the 90's from one that focused on effects of media on the audience to one that emphasized the empowerment of participants. This paradigm shift might explain

why creative media production was rare in early media education in the 80's and 90's, when educators mostly focused on critical understandings of text or Internet searches. During the same time period, programming as a form of creative media production moved from near-universal presence to extinct practice as navigating multimedia applications, searching the Internet and preparing PowerPoint presentations became the hallmark of digital literacy in school settings (diSessa, 2001). In addition, other researchers have referred to the "geek mythology" associated with programming culture (Margolis & Fisher, 2002; Schofield, 1996), making it appear an exclusive "clubhouse" that is not accessible to girls and minorities. It could well be that this whiff of exclusivity and the relatively high status of computer programming also hampered media educators' interest in considering these tools accessible for youth. Others also noted that the accessibility and costs of production equipment kept these tools out of reach for most youth (Sefton-Green, 2006). In the case of programming, however, it was not finances but rather the lack of experience and cultural perceptions that limited access and participation in creative media production.

In today's participatory culture (Jenkins et al., 2009), media productions and writings are far more commonplace. In Ito and colleagues' view (2009), the majority of youth are already contributors and producers of media when looking at social networking and blogging sites – an observation that is also bolstered by numerous other national surveys (Rideout, Foehr, & Roberts, 2010; Lennart & Madden, 2007). These scholars distinguish between friendship-driven activities, such as sharing information on social networking sites, and interest-driven activities, such as contributing to blogs, designing animations, graphics and video productions. Particularly the interest-driven social activities characteristic of "messing around" and the interest-driven activities characteristic of "geeking out" (Ito et al., 2009) lead into a territory formerly occupied near exclusively by the techie crowd. These types of creative media production are now being attributed to a growing Do-It-Yourself, or DIY, movement (Guzetti & Yang, 2010; Knobel & Lankshear, 2010; Spencer, 2005) that brings together the previously disparate communities of computer education and new media educators in unexpected ways. While initially the term "DIY" referred to home improvement projects, it has now become part of the Internet space, most prominently on YouTube where over 500,000 videos have been tagged as providing do-it-yourself information. One aspect that is of interest to us concerns self-made media artifacts by youth and how this relates to new media literacies. The ubiquity of webcams and the ease of doing simple, and even more complex video production, plus the YouTube distribution model has evidently led to a lot of sustained video production ("channels") and, with time, these seem to grow more technically sophisticated, or at least more experimental. Our next section will review different ways in which DIY is taken on in school and community spaces.

Creative Media Production as DIY

In conceptualizing creative media production as DIY, we are drawing on a small but growing body of work that has studied youth practices in schools, afterschool clubs and community technology centers (Guzetti & Yang, 2010; Knobel & Lankshear, 2010; Spencer, 2005). While the term "DIY" has only recently become officially attached to these efforts, they all share the spirit of self-produced and originated projects. For instance, one of the few mentions of DIY in and around schools appeared in a recent ethnographic study of youth and new technologies (Ito et al., 2009) that focused on a high school lunchtime computer club as a breeding ground for DIY youth culture and DIY capitalism. In the former case, a young artist represented a DIY approach to creative media production in the creation of his own Manga. In the latter, another youth engaged in the economic aspect of DIY entrepreneurial activity by selling ramen and refurbished computers. It is especially prescient that these DIY efforts were supported within the context of an informal, lunchtime computer club, rather than traditional classrooms. Similarly, in a DIY approach to writing and publishing, Black's (2005, 2009) research on fan fiction sites and Guzzetti and Gamboa's (2004) research on youth's use of zines point to ways that youth are enjoying academic styles of writing, publishing, and critiquing in the out-of-school hours, positively developing their identities as writers in the process.

Within the classroom context, researchers have begun to bring in popular DIY forms of writing and publishing. For example, Lankshear and Knobel (2003) have explored youths' blogs as potent forms of "Do-It-Yourself Broadcasting", creating links to academic writing while making connections to potentially broad audiences, informing affinity groups among youth. Other researchers, including Congdon and Blandy (2003) have introduced zines into the classroom to engage youth in both the writing process as well as the participatory culture. In Kahn-Egan's view (1998), writing can also become a form of DIY activism. In his work titled, "Pedagogy of the Pissed," he showcases the use of punk fanzines and a countercultural zeitgeist in his undergraduate writing courses. Furthermore, Guzzetti and colleagues expand these discussions and evangelize DIY media practices as both a type of classroom activity as well as literacy in their own right (2010).

Other approaches have focused on game design activities in which youth use construction kits or programming languages to design their own games or modify existing games. For instance, in Gamestar Mechanic, a player is invited to play, design, and share top-down and side scrolling videogames in a highly scaffolded environment. By contrast, in the programming language Scratch, players either modify existing games or design their own using visual programming. Designing videogames in Scratch allows players to have greater control over the types of avatars and interactions they have in-game but the environment is open-ended and thus provides no specific scaffolding to create games. Today, programming or designing games is by far one of the most popular DIY approaches inside and

outside of schools (e.g., Hayes & Games, 2009; Peppler & Kafai, 2007; under review) in a surprising alliance of promoting girls' interest and skills in technology (Denner & Campe, 2008; Heeter & Winn, 2008; Pelletier, 2008). A range of different tools such as Alice (Kelleher, 2008) and Scratch (Resnick et al., 2009) have been designed that facilitate the creation of media in 3D (Alice) for storytelling and game designs in Scratch which we will discuss later in more detail. Even media literacy researchers such as Buckingham and Burn (2007) and Salen (2007) are using game design now as an equally valid approach for promoting the new literacies in education. For them, game design combines cultural experiences that vary by age, gender, cross-media knowledge, and appreciation of particular features and genres. Game design encapsulates multiple professional practices, including expertise "in graphic design (visual design, interface design, information architecture), product design (input and output devices), programming, animation, interactive design (human computer interaction), writing, and audio design, as well as experts in content areas specific to a game" (Salen, 2007, p. 318).

Similarly, work in community technology centers such as the Computer Clubhouse (Kafai, Peppler & Chapman, 2009) provides another context in which youth are engaged in making their own media artifacts. In particular, our work has focused on Scratch as a DIY software production tool because youth can make their own software for games, digital stories, simulations, interactive art, dance videos or other genres of work. The Scratch community's DIY culture is unique because it uses programming as a means to engage youth in facets of creative media production. Since its introduction in 2008, the online Scratch community has quickly grown to over a half-million registered users and over a million uploaded projects (see scratch.mit.edu). Scratch differs from other visual programming environments (Guzdial, 2004) by using a familiar building block command structure (Maloney, Burd, Kafai, & Rusk, 2004; Resnick, Kafai, & Maeda, 2003), eliminating thorny debugging processes and the risk of syntax errors (see Figure 1). Futhermore, programmed objects can be any imported two-dimensional graphic image, hand-drawn or downloaded from the Web, to further personalize each project. This makes it particularly amenable to an array of novice programmers wanting to build their own software and engage in the participatory culture.

In previous studies, youth likened Scratch to paper (Peppler, 2010), as the program's flexibility allowed them to create projects in whatever style or genre they wanted, even enabling them to imitate flash-based media, TV, and videogames. This is further evidenced by the vast multitude of project genres represented in the Scratch online community, ranging from digital stories and interactive art to music videos and simulations. For example, one youth's digital story, "CreationStory", alternates between text on colored background and animated sequences featuring moving characters and speech bubbles to depict theories of creation in different cultures (see Figure 2). In another example, a youth used Scratch to create a virtual calculator, one that responded to addition,

subtraction, multiplication and division. In yet another example, one youth programmed their music video, "DanceDressUp", to facilitate user interactivity, where four onscreen dancers in an urban cityscape respond to specific key commands on the keyboard (see Figure 3). Each of these projects has a distinctive visual aesthetic, determined by the programmers' choices of hand-drawn or imported graphical elements. Furthermore, the programmers' varied approaches to user interactivity and interface create very different experiences for the player, in each case rendering the Scratch software "invisible" by making each project the unique representation of its creator, regardless of their level of programming ability.

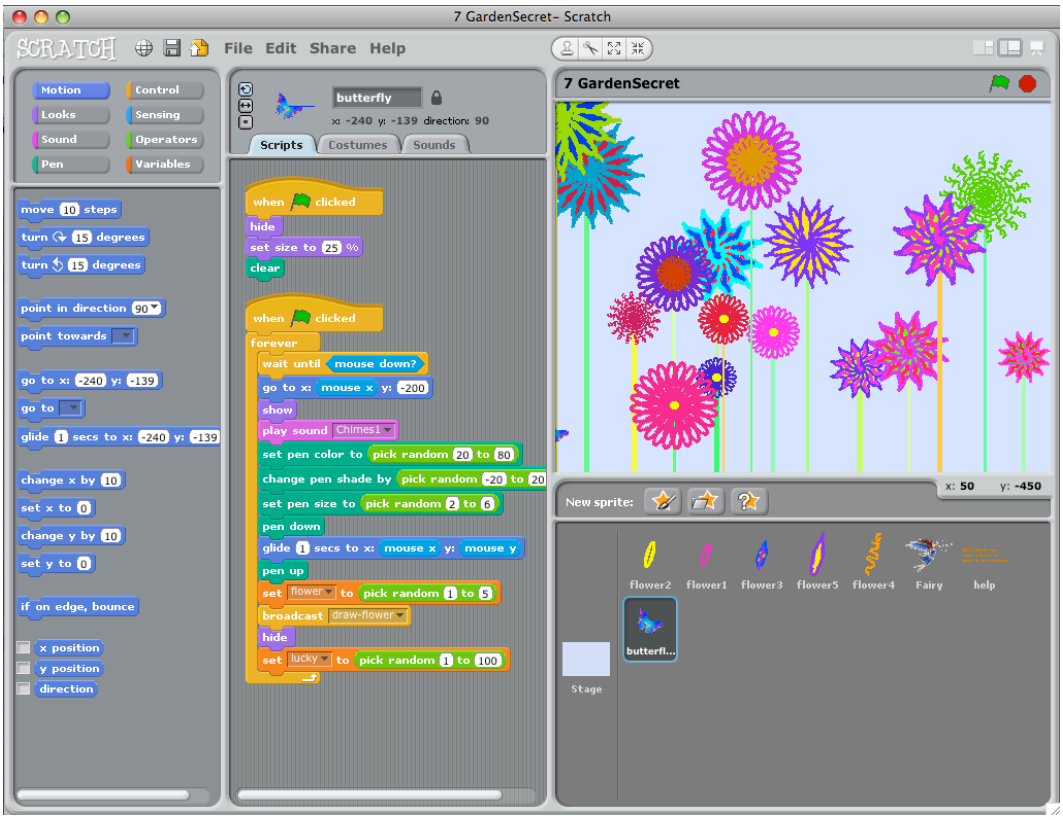

Figure 1: Screenshot of the Scratch User Interface

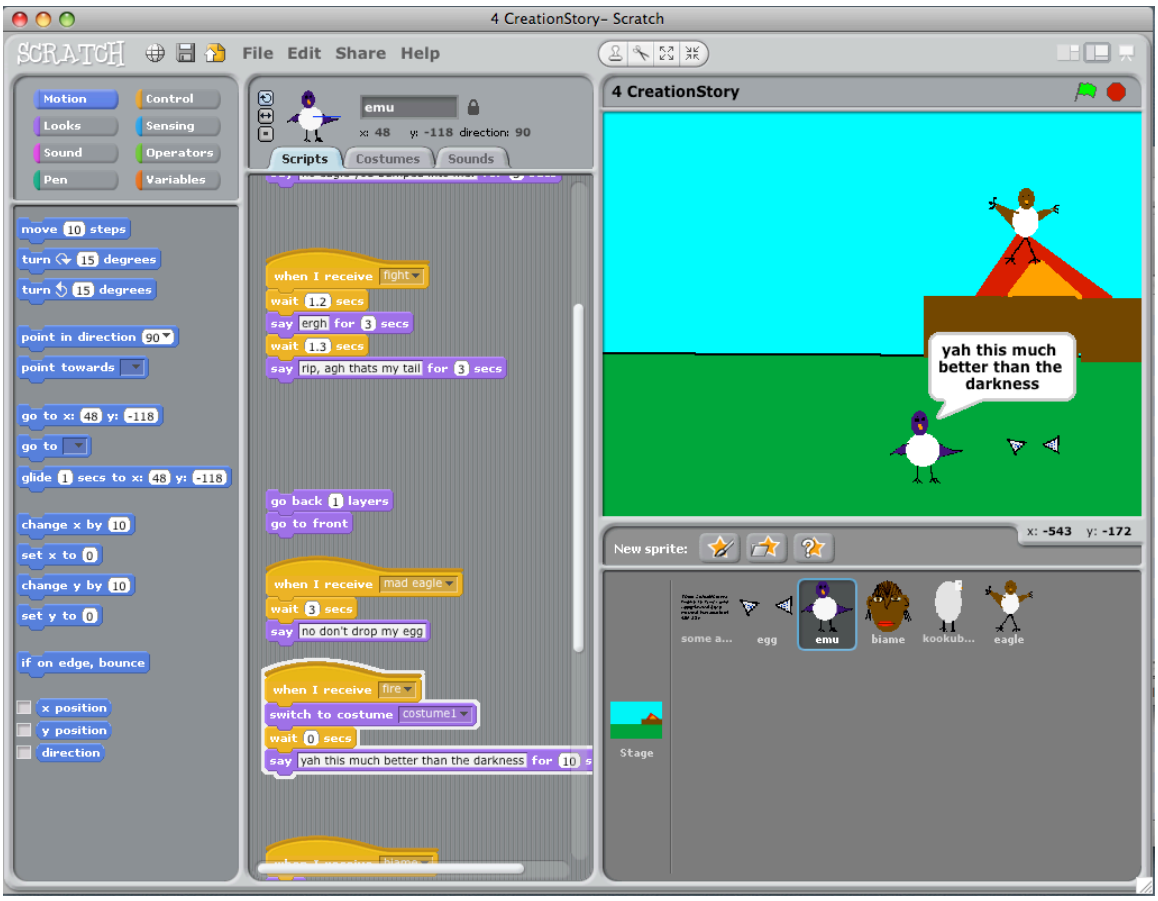

Figure 2: Screenshot from the Scratch project, *CreationStory*

These efforts inside and outside of school are bolstered by an even larger movement in many other DIY communities that use programming as a tool for their productions. There are now communities around sites like makezine.com or instructables.com where members have posted hundreds of thousands of videos on virtually any topic (Torrey, McDonald, Schilit & Bly, 2007). In some cases, these communities follow the open source movement and have networks develop around the use of a particular programming language, Processing (Reas, 2006a/b; see also processing.org), which is used in the design and media arts community. In other cases, these communities have developed around the use and development of an open-source construction kit, called Arduino, that hobbyists around the world use to design projects, such as their own laser printers. In the instance of the Lilypad Arduino kit (Buechley & Eisenberg, 2008), textile productions now can include sensors and LED lights to be programmed for informative feedback and artistic purposes. While these DIY communities have much of the flair of exclusive clubs found among earlier programmers, their growing presence also signals a larger trend.

As Ito and colleagues noted in their multi-site ethnography, only a small subset of youth engage in these type of "geeking out" or DIY activities. This invariably

brings to mind issues of the digital divide that have been described elsewhere in more detail (Warschauer & Matuchniak, in press). And yet, while access still remains a considerable issue for particular demographic groups (in which minorities are overrepresented), new discussions of a "participation gap" uncover issues that might be more at the heart of the matter. Jenkins and colleagues (2006) argued that policymakers and educators face three issues as they attempt to bridge the gap between those that contribute and those that don't: the participation gap, the transparency problem, and the ethics challenge. These three issues encompass the need to ensure that every young person has access to the skills and experience needed to become a full participant, can articulate their understanding of how media shapes perception, and is knowledgeable of emerging ethical standards that shape their practices as media makers and participants in online communities. While Jenkins and colleagues (2006) view the participation gap as the unequal access to the opportunities, experiences, skills, and knowledge necessary to prepare youth for full participation in a digital culture, we expand upon this notion and apply it specifically to DIY, which can be vehicles of change as both critical consumers and designers in an industry that has an increasing importance for schools and society at large.

Figure 3: Screenshot from the Scratch project, *DanceDressUp*

Participatory Competencies in Creative Media Production

As highlighted above, DIY youth are participating in diverse efforts to make and remix a variety of media. As youth engage in this work, they are not just participating in the DIY movement, but they are also engaged in multiple literacies and learning to authentically participate in a number of communities (New London Group, 2006; Guzzetti & Yang, 2010; Lankshear & Knobel, 2010). We introduce participatory competencies as a convergence of diverse literacies important to the DIY culture and draw on our early work in this area (Peppler, 2007) and that of others (Gee, 2010; Jenkins, 2006). We see youths' creative media production as part of a larger DIY effort in which youth engage, and provide a model of observation that expands the palette of previously conceptualized literacies to include a broader spectrum of design activities that are important to youth culture. Particularly, we add the artistic and creative forms that DIY projects take, the critical practices that are often left out of the discussion of youths' DIY efforts, and the ethical considerations in which youth engage. Building on Jenkins and colleagues' (2006) work, we argue that these technical, creative, critical, and ethical competencies are needed for full participation in the growing DIY culture (for an overview, see Table 1). In the coming sections, we will review prior work in media education, computer education and arts education with the goal to provide a common language that can help us articulate a set of participatory competencies found in DIY production.

Technical Practices. Analyses of these communities reveal that youths' technical DIY practices often include learning computer education concepts and skills (e.g., sustained reasoning, managing problems and finding solutions, and using graphics and/or artwork packages to creatively express ideas) as well as high-level skills such as algorithmic thinking and programming (Cunningham, 1998; diSessa, 2001; Maloney et al., 2008). Programming within the context of DIY is a particularly important technical practice because it allows the creator to manipulate the medium of the computer (Peppler, 2010; Reas, 2006 a/b). In an effort to introduce the essentials of programming and other technical skills to youth, we argue that learning to code is important but by no means the only building block for understanding how digital media is designed; it can also provide an additional venue for originality and expression in digital media. We have identified in Table 1 three central technical practices that are important to youths' creative digital production: *coding* (which involves the use of loops, conditional statements, parallel execution, object-oriented programming, sequencing, synchronization, time triggering, real-time interaction, Boolean logic, variables, event handling, user-interface design, statements, and numerical representations [Malan, 2007; Maloney et al., 2008]), *debugging* (practices of persisting when confronted with technical problems either prior to or during production [National Research Council, 1999]), and *remixing* (the practice of reusing earlier ideas or chunks of materials to build upon in a single or in multiple works [National Research Council, 1999]).

We have already noted that the new literacies studies community has studied forms of "geeking out" (Ito et al., 2009) but their efforts have primarily focused on particular kinds of activities such as video making, graphics, blogging, fanzines, and cosplay (i.e., engaging in costume play based on popular media characters), thus overlooking the role of programming as a form of creative media production. This largely ignores a number of DIY communities that use programming as a core tool for creative media production, including robotics communities, e-textile communities, and programming communities like those that have evolved around Scratch, Arduino, and Processing languages. For instance, Processing is a programming language, development environment, and online community that have promoted software literacy within the visual arts, graphic arts, and design communities. Processing.org is a novice-friendly, open source community where individuals can post projects, share code, learn more about programming, and take part in curated online exhibitions. Of course, these programming activities involve, to some degree, fairly technical knowledge of scripting and other aspects of visual programming, but this specialized skill set is not unique in the world of creative media production. In fact, it parallels the history of video and audio production in the media education curriculum, which originally involved fairly difficult technical skills. And, as the tools became cheaper and easier to use, the more readily they were adopted by schools and particularly by media educators. Now, as programming tools become easier to use – even easy enough to allow pre-literate youth to program before their able to read and write (Peppler & Warschauer, 2010) – we may see a similar trend to embrace such tools in the new media literacies community.

DIY communities themselves publish a great deal of work on how tools, techniques, and instructions on how to do “do-it-yourself” programming and physical computing (see makezine.com and instructables.com for example), so it’s not surprising that technical practices have long-since guided these informal discussions. In newer iterations, large online communities have grown around more beginner-friendly tools like Alice, Scratch and Processing, sharing ideas and remixing one another’s work. These new tools further reshape contemporary literacy practices in DIY communities, helping youth to meet the goals of becoming fluent with technologies. Computer programming, for example, is a central tool that has entered the new landscape. We use computer literacy synonymously with the term “technology fluency” to expand what it means to be literate with technology as we move beyond just basic functions, such as word processing and web surfing, to higher end skills and dispositions (diSessa, 2001; National Research Council, 1999). In our view, computer literacy includes higher-level skills and concepts such as algorithmic thinking, programming, debugging, and repurposing bits of information or code.

Table 1. Overview of Technical, Critical, Creative and Ethical Practices of DIY Production

Participatory Competencies	**Practices**	**Definitions**
Technical Practices of Production	Coding	Practice of computer programming, particularly the use of loops, conditional statements, parallel execution, object-oriented programming, sequencing, synchronization, time triggering, real-time interaction, Boolean logic, variables, event handling, user-interface design, statements, and numerical representations (Malan, 2007; Maloney et al., 2008).
	Debugging	Practice of persisting when confronted with technical problems either prior to or during production (National Research Council, 1999).
	Repurposing	Practice of reusing earlier ideas or chunks of materials to build upon in a single or in multiple works (National Research Council, 1999). This is also a common practice particularly in the professional computer programming community.
Critical Practices of Production	Observing & Deconstructing Media	Careful observation by youth looking more closely than ordinarily at everyday objects (Hetland et al., 2007) and deconstructing the both the parts of the text (at a literal level) and the meaning behind the text.
	Evaluating & Reflecting (i.e., Critique)	Practice of peers negotiating what constitutes a "good" project (Soep, 2005; Peppler, Warschauer & Diazgranados, 2010). Asking one another (even informally), given a particular artistic goal, how successfully has this goal been met?
	Referencing, Reworking & Remixing	Practice of creating original works that make knowing reference to previous works (such as games, cartoons, music, etc.). Wholly original work produced as art fall into the category of playable art and are excluded from this category (see Mitchell & Clarke, 2003). The modification of existing games, images or sounds, often to create new interactive pieces or "machinima" or non-interactive movies. Also the act of creating new genres, combining genres, or taking something from one genre and making it into something else (see Erstad et al., 2007).
Creative Practices of Production	Making Artistic Choices	Practice of learning about, appreciating, and applying artistic principles (similar to Gee, 2003), including choosing objects as well as their colors, size, movement, and on-screen positioning. This is further defined as working within a single modality to augment meaning.
	Connecting Multimodal Sign Systems	Practice of learning about, appreciating, and designing interrelations within and across multiple sign systems (images, word, and action) (Gee, 2003; Kress & van Leeuwen, 2001; Jewitt& Kress, 2003). This is further defined as working across two or more modalities to augment meaning.
Ethical Practices of Production	Crediting Ownership	Practice of referencing intellectual origins of 'text' in use of media production (Perkel, 2009).
	Providing Inside Information	Practice of judiciously sharing insider codes, shortcuts, and solutions according to the cultural values in community (Fields & Kafai, 2010)

In the context of digital production, learning to computer program is often a central component of becoming "software literate" or having the ability to create novel user interfaces with the computer. This type of creativity with technology is at the core of what professionals are able to do with new media and it overlaps with what Smith would describe as "computational flexibility" (2006). Being computationally flexible builds upon literate practices involving knowing how to use computationally rich software (e.g., word processors, spreadsheets, and presentation tools) as well as develop fluency (i.e., knowing how and why existing tools do not meet current needs), but extends this to include the ability to create the tools that one can otherwise only imagine.

Critical Practices. More recently, several approaches have examined DIY cultures as a way to involve youth in critically viewing media and using this understanding when creating original work. As youth begin to take advantage of living in a digital world by capitalizing on the wealth of images, sounds, and videos accessible as "materials" to reuse in their own work, media educators grow particularly concerned about the ways in which youth are might be reinscribing or questioning existing dominant norms (Buckingham, 2003; Buckingham & Burn, 2007). Such critical practices include youth being able to critically reflect on and evaluate media texts, understand references made in popular texts, and deconstruct and interpret the meaning behind such texts (Peppler & Kafai, 2007). By observing the critical practices of DIY youth in this way, we gain an understanding of the extent to which young designers understand and question the popular texts that they incorporate in their work, apart from what they learn about software programming and new media. Additionally, as youth engage in DIY efforts, they are learning to critically read and write the world. Critical practices are those that enable youth to make meaningful statements about local conditions and even their larger societal contexts, and include practices like observing, deconstructing, remixing, or critiquing media or larger socio-political structures.

More specifically, we identified three sets of practices: *observing and deconstructing media*, *evaluating and reflecting*, and *referencing, reworking and remixing*. *Observing and deconstructing media* practices involve careful observation by youth looking more closely than ordinarily at everyday objects (Hetland et al., 2007) and deconstructing both the parts of the text (at a literal level) and the meaning behind the text. *Evaluating and reflecting* (i.e., the practice of critique) practices involve peers negotiating, for example, what constitutes a "good" project (Soep, 2005; Peppler, Warschauer & Diazgranados, 2010), or by asking one another (even informally) how successfully a goal has been met given a particular artistic goal. Finally, *referencing, reworking and remixing* practices include the creation of original works that make knowing reference to previous works (such as games, cartoons, music, etc.). Wholly original work produced as art fall into the category of playable art and are excluded from this category (see Mitchell & Clarke, 2003), while the modification of existing games, images or sounds, often to create new interactive pieces or 'machinima' (or non-interactive movies) are included. We include here also the act of creating new genres,

combining genres, or taking something from one genre and making it into something else (see Mitchell & Clarke, 2003).

In education today, one must arguably deal with the pervasive contemporary visual culture familiar to youth. Learning how to appropriately remix (Manovich, 2005; Perkel, 2006; Erstad et al., 2007) and rework popular media is a key skill needed for developing a sense of criticality. In our prior work, we've found that much of youths' creative media production in new media has entailed a great deal of reworking or remixing of popular media texts such as videogames and music videos (Peppler & Kafai, 2007a/b) and further that this "remixing" of popular texts led to sustained creative media production over the course of several days at the after-school center (Peppler, 2007). This work demonstrated that youth who made reference to popular culture texts in their work (i.e., Beyoncé, Bart Simpson, Chris Brown) were invariably likely to persist in creative media production for more than a day at the after-school center, as opposed to projects without such references were half as likely to persist (Peppler, 2007). The act of remixing involves selecting and combining semiotic resources into new multimodal texts (Erstad et al., 2007). Erstad and colleagues have focused on the remixing of such resources because it moves youth fluidly between analysis and production – between critically reading and writing semiotic texts. As such, a new media studies lens contributes to our understanding of youths' relationship to popular culture as they engage in creative media production by shifting our focus away from traditional conceptions of self-expression to the skills that prepare youth for engagement in a participatory culture. Jenkins and colleagues (2006) outline eleven such skills that, while building on a foundation of traditional literacy, research skills, technical skills and critical analysis taught in the classroom, focus instead on communal skills that are developed through collaboration and networking, including youths' ability to meaningfully remix media content, evaluate the credibility of different information sources, and follow the flow of information across multiple modalities, among others.

And to what ends do youth use such literacies? Historically, efforts to articulate the goals of media education have emphasized critically consuming popular media as a core aim of any media education curriculum (Masterman, 1980, 1985; Ferguson, 1981; Alvarado et al., 1987). This is also a shared aim in the field of arts education, which has previously emphasized critically evaluating and reflecting on visual culture (Hetland et al., 2007; Soep, 2005). By observing the process through which youth transform from consumers to creators of new media, we can assert that it's not just in the consumption of media but also in its production that youth develop a critical lens of popular culture. We have argued in our previous work that it's possible to develop a critical lens through participation in creative media production, even in informal learning spaces (Peppler & Kafai, 2007a). The extent to which these practices represent the larger community is unknown and is at the core of our rationale for investigating vast data sources that were amassed by multiple members of the community.

Creative Practices. Youth involved in DIY efforts expand beyond Technical and Critical considerations toward creative or artistic ends. Researchers have explored different media cultures, such as those found in punk, zines, and cosplay, that outline the aesthetic and symbolic language encoded in the dress and costumes in these popular sub-cultures (Guzzetti & Gamboa, 2004, 2006; Manifold, 2008). For instance, in punk culture, youth adhere to a specific style of dress in order to communicate membership, whereas in cosplay, youth use dress and costume to represent and re-enact media figures such as found in comics and movies. As youth encode and decode the dress and other iconic imagery that is worn by members of the group, they are honing skills in line with the new literacies studies and multimodal theories of literacy, such as the importance of being able to interpret and express original ideas in a variety of modalities (such as through music, dance, sculpture, or dramatization), and are frequently able to make meaningful connections between two or more of these modalities (Kress & van Leeuwen, 1996; Gee, 2003). In observing creative practices as they pertain to youths' DIY designs, we have observed that youth learn about and appreciate artistic principles by *making artistic choices* within a single modality (e.g., visual, audio, or kinesthetic), as well as by *connecting multimodal sign systems* across two or more modalities (e.g., visual and sound, visual and movement or gesture, and sound and movement) to convey an artistic idea (Peppler, 2010).

For instance, when making artistic choices, designers learn about, appreciate, and apply artistic principles, including choosing objects as well as their colors, size, movement, and positioning. For example, in the Scratch project, "Robot Dance," the designer worked with a variety of artistic principles in order to create three-dimensional perspective (see Figure 4). Heightening the visual realism of the image, the designer used lines on a disco dance floor that converge into a single vanishing point. To create an illusion of depth, dancing robots diminish in size as they approach the horizon line. In both of these instances, the realism of the piece is achieved through the designer's choices within a single, visual modality. To further augment the meaning of the piece, the designer introduced animation and audio to the project, with flashing lights on the robots that change colors in synchronization with the flashing of an overhead disco ball, accompanied by a robotic-sounding disco track. The aligning of visual, audio, and animated effects then become part a unified message to the viewer. In the connecting of multimodal sign systems, designers learn about, appreciate, and design interrelations within and across multiple sign systems (images, word, and action), further defined as working across two or more modalities to augment meaning. Youths' use of these practices demonstrates a more in-depth understanding of the complexity of new media production.

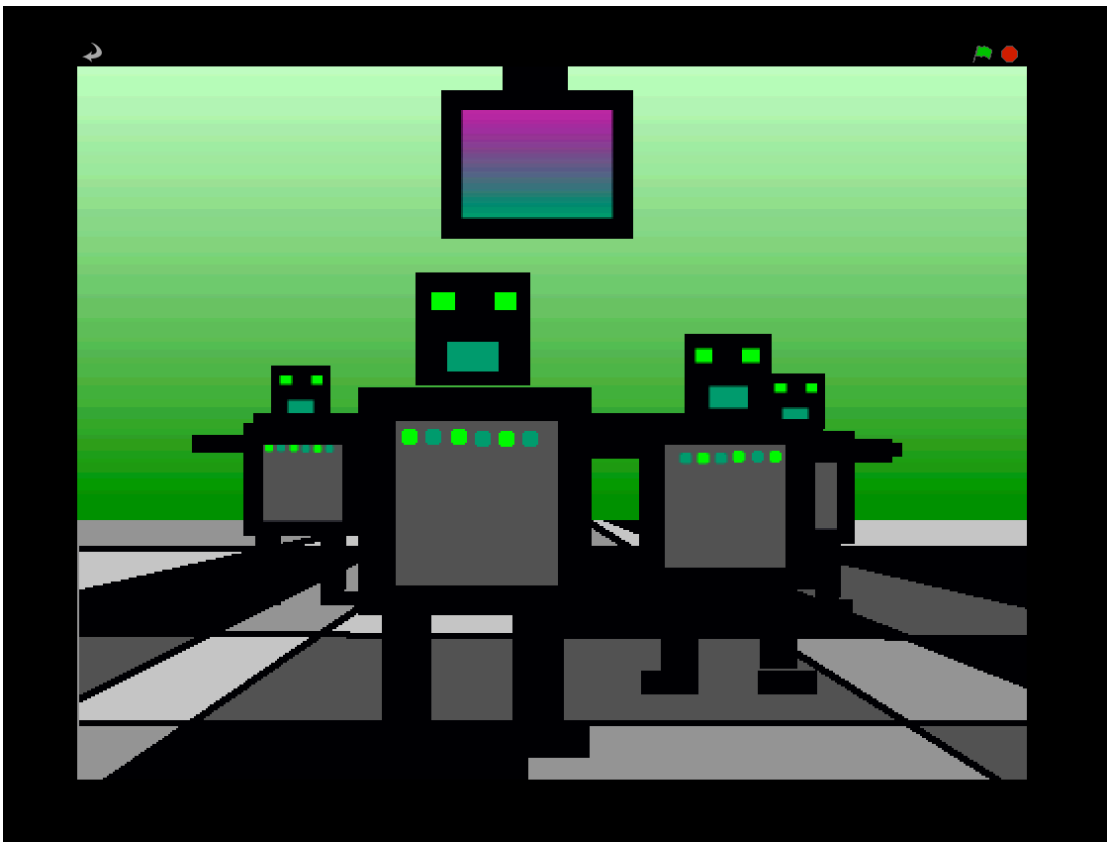

Figure 4: Partial Screenshot from the Scratch project, *RobotDance*

Scholars have argued for a view of art as the creation of meaning (Dewey, 1934/1980; Eisner, 2002), which shares many of the underpinnings of the aforementioned theories in the study of literacy. As youth make artistic choices in traditional subject areas such as the visual arts, they are learning about the grammar of visual design, which posits that aesthetic choices are culturally understood and put together in meaningful combinations (Kress, 1996). Similarly, other related art fields have attempted to articulate semiotic theories of action (Martinec, 1998), sound (Van Leeuwen, 1999), and theatre (McInnes, 1998), among others. As youth use any of these modes in their work, they learn about cultivating various types of novice understandings about various design grammars, whether they be visual, action, sound, or theatrical. For example, a sub-community of DIY producers in South LA began making Scratch projects based on Low Riders—highly personalized cars often characterized by having low suspensions and original paint and hubcap designs. Low Riders originated circa WWII in the Mexican-American community as a form of DIY car customization and is now a prominent DIY practice within urban communities (Cowan, 2004). Scratch designers appropriated the Low Rider discourse while playing with grammatical conventions to convey aspects of Low Rider cars that would be unable to be represented through visuals alone (e.g., simulating the bouncing motion of hydraulic suspensions) (Peppler & Kafai, 2007). In doing so, the small choices that they made in the composition became more meaningful. As youth make a series of choices, this ultimately leads to more fuller forms of

literacy as they become more practiced in these decision making processes. One might wonder whether expertise grows over time in these informal communities, and, indeed it does. Pre and post-test analyses revealed that youth learned about the big ideas of computer programming as well as visual/multimodal media arts production over the course of two years in absence of direct instruction (Peppler & Kafai, under review; Maloney, Peppler, Kafai, Resnick, & Rusk, 2008). These analyses were consistent for individual learning as well as community learning (i.e., new members were being apprenticed into the community to produce more sophisticated work over the course of the study).

While prior work has focused on monomodal domains of the arts and articulated the associated grammars of each individual system of communication (i.e., visual, auditory, oral, etc.), researchers are now promoting a multimodal view of literacy and learning that is key to understanding newer digital art forms (Kress & Van Leeuwen, 2001; Narey, 2008). These efforts broaden our conceptions of multimodal literacy and what it might mean to "make meaning" across a range of modalities. By nature of media art being a meta-medium, there is plenty of opportunity to develop a multimodal literacy, which is the interaction and combination of multiple modes of communication (Kress & Van Leeuwen, 2001; Jewitt & Kress, 2003). Multimodal literacy challenges dominant ideas around learning and representation, arguing that people work across a range of representational and communicational modes involved in learning through image, animated movement, writing, speech, or gesture in new media (ibid). Scholars like Kress and van Leeuwen have attempted to move the discussion beyond the different modes of communication (i.e., language, image, music, sound, gesture, etc.) as separate discourses, and have instead strived to outline a coherent grammar of new media. They point out that across semiotic modes, similar meanings can be established in different modes. In order to unify prior theories at devising grammars of any singular modality, Kress and van Leeuwen sought out to articulate common principles across a variety of modalities in their outline of multimodal Discourse.

However, literacy goes beyond reading such multimodal forms to creating them and, in doing so, learning to write these discourses. In the creation of new multimodal forms of media, Jewitt and Kress (2003) argue for two central practices in their theory of multimodal literacy, including "design thinking" as encapsulating the intentions of a designer in absentia of the materials and the "production thinking" that goes in the realizing of those ideas in the materials. DIY communities deeply engage in both forms of thinking as they imagine, create and share their work with others. As youth design with Scratch, oftentimes they have project ideas that are inspired by popular media, including videogames, MTV dance videos, and other types of media. They go through a series of steps in their design thinking, choosing their characters (e.g., the Incredible Hulk and Spiderman) as well as how they will interact (e.g., in a battle to see who's the strongest). Oftentimes, in this stage of the design thinking youth come up with fairly complicated ideas. As they settle into the process of Scratch production, this

thinking takes a shift to operationalize the steps needed to accomplish the project (e.g., first finding the images on Google image search, then downloading to the desktop, then importing them in their Scratch project, etc.). This shift toward production thinking calls into question a number of the earlier decisions made in the design thinking process, which results oftentimes in a more streamlined, simplified product that deals with the constraints of the media as well as the technical expertise of the designer (e.g., hand drawing images when you can't find what you would like on the Web). In sum, creation within a multimodal medium tasks users to make sense of individual modalities with the ultimate goal of making connections between several different types of modalities. Engagement in creative media production, therefore, is the act of developing literacies in uni- and cross-directional ways, and gaining the ability to translate one type of literacy to another.

Ethical Practices. Popular DIY practices, like remixing, bring up important issues of ethics in new media literacies. For example, the ease with which a MySpace user can access and appropriate content from others' pages can be problematic (Jenkins et al., 2006). In our prior work, this feature of new digital media spurred a lively debate in an after-school Scratch club (Kafai, Fields, & Burke, in press). Similarly, Perkel (2008) describes his encounter with Sharon, a fifteen-year old aspiring photographer who placed a number of her photographs online only to discover they had been subsequently copied and spread over multiple websites – MySpace pages included. When asked if she considered such copy and paste appropriation to be some form of a compliment, Sharon replied that she actually saw it as an intrusion of her privacy. "No, I don't feel complimented," she remarks incredulously. Sharon subsequently removed the remainder of her pictures from online, unwilling to allow them to also become future fodder for remixing. "This kind of activity," writes Perkel in his blog, "deeply upset Sharon's sense of right and wrong." The ease with which her pictures could be accessed and appropriated directly led to wider ethical considerations.

Ethical practices then add a fourth dimension to the critical, technical and creative DIY practices and deserve further examination, especially when individuals are re-appropriating others' work for their own purposes. The fact that such activity is occurring in schools further complicates the issue. Schools, in general, have a precise notion of cheating, but this rather rigid conception of what constitutes cheating does not necessarily serve kids well when it comes to the ethics of creating video games and online content where the cut and paste feature is commonplace in sites like MySpace. While research (Consalvo, 2007; Salen & Zimmerman, 2004) recognizes the practice of cheating in video games to be complex and occurring for a whole assortment of reasons, schools too often treat cheating as a "black and white" issue that happens simply due to some ethical failure on the part of students.

By contrast, two other types of ethical practices that we have observed in youths' creative media production include *crediting ownership* and *providing inside*

information. Crediting ownership consists of referencing the intellectual origins of "text" used in media productions. For instance, remixing Scratch projects (i.e., taking an existing project and modifying code or graphics) is a common practice in the larger Scratch community; in fact, over 40% of all projects posted on the web site are remixes of existing Scratch projects (Senivirate & Monroy-Hernández, 2010). In an after-school club, Scratch programmers ages 10-12 years were adamant that their fellow programmers credited the origins of programs that they had remixed and posted online. While Scratch programmers initially were concerned about other taking their programs, they also came to understand the remixes as a form of recognition that represented attention they received from others (Kafai, Burke, & Fields, 2010). An example of providing inside information includes the practice of judiciously sharing insider codes, shortcuts and solutions according to the cultural values in the community. We located over two hundred cheat sites on the Internet that players of the virtual world Whyville.net had designed for new visitors to provide them with solutions to science games and tips on how to style their online avatars. The online newspaper written by the Whyville players featured articles that debated the pros and cons of different forms of cheating and their impact of game play (Fields & Kafai, 2010). Notably, what consists of cheating —whether it's revealing a solution to a puzzle or whether it's copying code—differs across contexts and what might be a perfectly permissible way of sharing information within another community might not be acceptable in another.

Summing up, we see DIY participatory competencies are comprised of four inter-related practices (i.e., the Technical, Critical, Creative, and Ethical practices) rather than having a single focus. Building on our prior work, we conceptualize the intersection of these practices as four overlapping circles in a Venn diagram. Each of these sets of practices then aligns with the authentic and meaningful practices of experts. Any overlap of two or more circles creates an area that best describes the domain of youths' DIY practices – it's really at this intersection that youth work, crossing disciplinary boundaries and moving fluidly between these four types of practices. This conceptualization is grounded in the findings from the current study, as well as our earlier work (Peppler & Kafai, 2007; Peppler, 2010; Fields & Kafai, 2010) but also builds on the extensive work done by researchers in the other fields.

Our descriptions of participatory competencies are not meant to be final, rather they are intended to lay out a roadmap for further investigations. For instance, we see the development of tangible media that extend creative media production into the physical realm as a promising candidate – a more detailed description can be found in next section. Such developments pose new but also interesting challenges to interface designs that have focused predominantly on visual aspects leaving out sensory qualities such as sound and texture that are equally informative. Other developments could focus on leveraging the large scale of social networks that youth navigate and contribute to with their creative media productions and would examine what it means to participate fully and actively in

such large communities. These changes in the materials and social aspects of media also generate new input for the developments of design and media arts. As technologies change, new practices are developed and integrated, and so will the need for participatory competencies.

Towards a Convergence of Participatory Competencies

For our final considerations, we return to the beginning of our review, that is the development of a common language to understand the multiple literacies involved in creative media production. We argued that given the changing nature of participatory culture, and what it takes to actively and fully participate in it, more emphasis is needed on students' acquiring of design and production skills. We see these developments as part of the burgeoning DIY movement that has its roots in youth and media culture promoting alternative production. Our focus on DIY as a context for creative media production is not a radical departure from prior approaches in media and computer education; rather we view it as complementary, expanding existing media literacy approaches that have previously focused on critical reflection and understanding to be more grounded in youths' creative practices. We have formulated a provisional list of advantages for DIY production with the intention of moving towards a convergence of literacies.

First, a common set of DIY practices increases flexibility and fluency when moving across platforms as well as aids in research of these practices. Youth that may not otherwise be involved in computer programming or a formal media education curriculum are now being drawn into the participatory culture through creative media production. The main point we're trying to make in this review is that particular forms of creative media production (programming) have not been part of the discourse of new media literacies in youth media engagement. Already, Ito and her colleagues (2009) provided a more multi-faceted account of the diverse forms of interest-driven participation in new media. When youth are 'messing around' or 'geeking out' in DIY, they invariably begin to use and master design languages – programming, interface design, animation, graphics, 3D design, and more. But in today's media culture, we lack a history of educating students about these features prominent in interface and software design, as most school activities are concerned with using rather than producing technologies. We argue that we should be equally concerned with "opening the black box" of digital technologies as about media ownership and control issues. In our own work, we saw numerous examples of how youth engaged in DIY production dealt with a host of complex interface design issues that reveal the underpinnings of software interactions. Such understandings are crucial for today's citizenship, as more aspects of life have moved into the digital domain. Interfaces happen to be one of the most difficult artifacts to design, as many assumptions about human interaction are built in, assumptions that most people are not aware of unless faced with designing them. Ultimately, we hope that this has an impact on issues

of access and participation at large, in particular who contributes to the design of new technologies and applications, some of which we discuss in more detail below.

Secondly, creative media production enables critical reflection on media culture, expressed through visual instead of oral or written discourse. What makes DIY a promising combination is not only its focus on creative media production but also how it highlights critical readings and equity issues. In DIY, some researchers see the construction and swapping of zines as a far more galvanizing activity – a decision to circumvent traditional modes of communication in order to establish particular affinity groups operating outside of mainstream culture. This pushback on the mainstream – and oft-labeled "consumerist" – culture is a central vein running the projects. Such motivations relate well to a perennial concern for media educators, that is the relationship between creative media production and critical media analyses. In our view, creative media production pushes youth to question their current observations and understandings, make explicit their assumptions about new media, and discover the conventions of writing the language of new media by learning the visual, semiotic, aural, and technological literacies necessary to inscribe one's self into the larger participatory culture. What takes place during creative media production is a critical reflection on what constitutes new media, how it is constructed, and how one would question or use these same design conventions towards different ends. The traditional role of formal media education still remains in media consumption because it involves stimulating critical reflection on a greater variety of media texts and engendering youth to critically write and reformulate those ideas. In this context, creative media production operates on two levels to serve both an educational and a cultural/political function in media education. Primarily, the educational function of creative media production lies in learning to write these multimodal texts but also in understanding the complexity of the design process. The cultural and political function of production includes a better understanding of larger issues about power, representation, and access: Who is doing the writing? Whose voice is being heard? Who is being positioned in certain ways within a particular text and for what purposes? In addition, the emphasis on writing empowers individuals to insert their self to redefine their position within these power structures.

Third, DIY production provides access to the digital equivalents of functional literacies of reading and writing. Previous discussions have cast this issue mostly in terms of access to digital equipment (the digital divide) instead of the participation gap, the transparency problem, and the ethics challenge (Jenkins et al., 2006). Here our work gathers particular relevance in light of the inequitable access and participation of minority youth in digital technologies. In the digital age, media education needs to foster both critical understanding and creative media production of new media to encourage urban youth to be consumers, designers and inventors of new technologies. Based on prior research, we know that the technology industry is not a welcoming place for women and minorities

but creative media production has been shown as a key avenue for change in the industry as it moves the field away from narrowly technical computer science applications to a focus on arts and design (Margolis & Fisher, 2002). We see the approach of creative media production as an appropriate and healthy counterpoint to a culture of consumption. While the boundaries between media consumers and producers are perhaps not as distinct as they used to be, there is still a large rift between those who own and control media and those that have the possibilities of creating them. To be a full member in today's participatory culture should mean much more than knowing how to play videogames, for example; it should also mean knowing how to design videogames.

So far, we have focused mostly on creative media production in DIY cultures. One could argue that we artificially imposed a separation of production from consumption (Lemke, personal communication) and furthermore, that such separation assigns values to design/production as "work" whereas play/consumption is devalued as non-productive, non-work, and non-serious. Indeed, the transitions between play and production in today's participatory culture are less distinct as some of the discussions in this chapter might suggest. We have promoted this distinction simply because we found creative media production a neglected topic in current discussions on new digital media and learning that deserved a more extended treatment. Moreover, the role of computer programming or computer literacy seems to be undervalued in the current climate, with an emphasis instead on safer web surfing, introducing Microsoft Office products, and other Flash-based videogames as the core of computer education in schools. In fact, all production involves, even requires, some form of consumption or play as an entrance point into the larger technology culture.

Our final observations are intended to look to coming trends on the developments in digital media that will impact youth's activities beyond the screen: namely, those aspects of media construction and design that dovetail with hands-on crafts, physical construction and design, and material play. There is a range of DIY practices already underway but one such example can be found in computational crafts, called electronic textiles (e-textiles). These include young people's design of programmable garments, accessories (such as jacket patches), and costumes. Such designs incorporate elements of embedded computing (for controlling the behavior of fabric artifacts), novel materials (e.g., conductive fibers or Velcro, etc.), sensors (e.g., for light and sound), and actuators (e.g., LEDs and speakers), in addition to traditional aspects of fabric crafts. Most notable are here developments of textile construction kits such as the Lilypad Arduino (Buechley, 2006) that can be placed into garments and where LED lights and sensors can be connected via conductive thread and programmed via the computer to interact with the environment. Such examples where creative media production moves from the screen into the physical space are not new but, unlike the familiar robotics construction kits, they appeal to different audiences and also integrate decorative elements. New DIY communities are emerging around these

materials, which will inevitably change the face of what we know about the larger DIY culture.

These extensions into the physical world suggest a vast expansion of the traditional notion of digital learning — one that can enrich youth's expressive and intellectual lives by combining the affordances of the virtual world with those of tangible media designs and creations. We argue that as today's notions of 'media texts' are expanding beyond print to include dress, speech, drawing, and dance, we need to consider how engagement with digital media can include tangible media texts. We're reminded of early formulations of the New London Group that saw all kinds of media as part of the new literacies, not just those that adhere to the flat surface of computer, television, video or phone screens: "Childhood cultures are made up of interwoven narratives and commodities that cross TV, toys, fast-food packaging, video games, T-shirts, shoes, bed linen, pencil cases, and lunch boxes...teachers find their cultural and linguistic messages losing power and relevance as they compete with these global narratives. Just how do we negotiate these invasive global texts?" (New London Group, 1996, p. 70). DIY production provides opportunities for personal expression, creativity, and critical reflection on media culture, expressed through visual instead of oral or written discourse and allows youth to reflect on their knowledge of culturally meaningful texts and dominant discourses and formulated a response through their work.

Conclusion

In this chapter, we focused on creative media or DIY production drawing on work from new literacy studies and technology education and provided a framework that would allow us to understand the multiple practices of learning and creating with new digital media. We applied this framework to research in the context of media-rich computer programming to illustrate the range of participatory competencies in practice. The larger goal of our chapter, however, is beyond the particulars of programming and argues that creative media production should be considered an essential part of our discussions of learning with new digital media, inside and outside of school.

Acknowledgments

This material is based upon work supported by the National Science Foundation (CIS-0855868 and 0855886) to the authors in addition to prior funding to the first author (ITR-0325828). We also thank our reviewers Jay Lemke, Mark Warschauer, Stanton Wortham and William Burke for their insightful comments on earlier drafts of this manuscript.

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